MANPRINT Applications to the LW155 Howitzer (M777)

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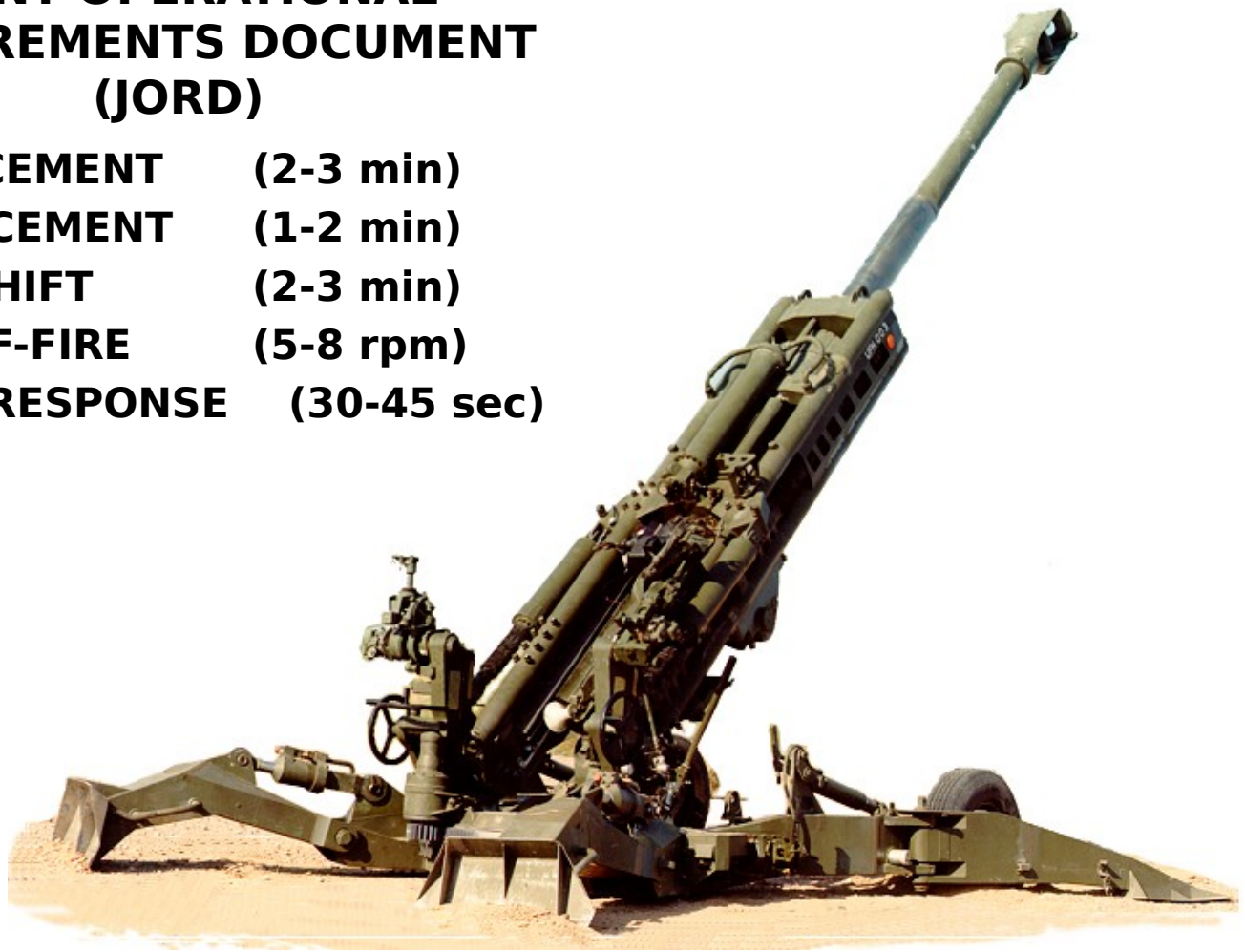
Outline

- **Previous Work**
- **User Tests – The next step**
- **Hardware Revisions**
- **Model Revisions**
- **Digital Fire Control**
- **Early User Assessment**

Previous Work

JOINT OPERATIONAL REQUIREMENTS DOCUMENT (JORD)

- **EMPLACEMENT (2-3 min)**
- **DISPLACEMENT (1-2 min)**
- **BOLD SHIFT (2-3 min)**
- **RATE-OF-FIRE (5-8 rpm)**
- **1st RD RESPONSE (30-45 sec)**

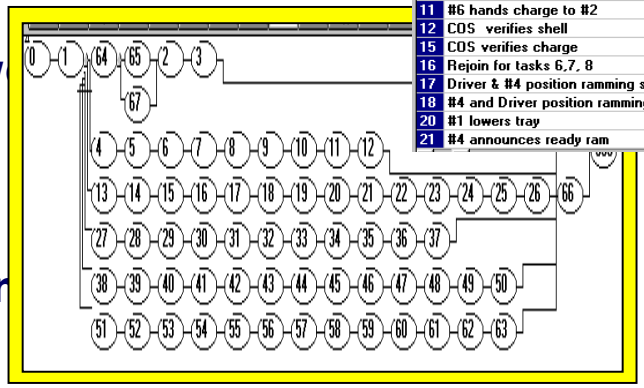


TASK NETWORK MODELING

IMPROVED PERFORMANCE RESEARCH INTEGRATION TOOL (IMPRINT)

- **Literature Review and Coordination**
  - Predecessor crew drills
  - Contractor developed crew drills
  - In-house modeling expertise
    - Marine Corps; Army Subject Matter Experts
- **Task Analysis**
  - Identify individual task
  - Determine task sequence (netw
  - Measure individual task times
  - Model estimates function time
- **Application**
    - Requirements risk reductior
  - Design modified
    - Crew drill optimization
    - Technical and operational testing

Ta	Task Name	TimeMean	Time StdDev	Distrib Typ
1	Fire Mission Alarm	00:00:00.00	00:00:00.00	Normal
2	COS announces 'fire mission'	0.7;	00:00:00.00	Normal
3	Driver checks & announces bore clear	00:00:01.70	00:00:00.00	Normal
4	COS announces charge xxxx	1.7;	00:00:00.00	Normal
5	Rejoin for tasks 3 and 4	00:00:00.00	00:00:00.00	Normal
6	COS announces deflection xxxx	1.7;	00:00:00.00	Normal
7	#6 prepares charge	00:00:05.00	00:00:00.00	Normal
8	4 carry projectile place on loading tray	00:00:03.40	00:00:00.00	Normal
9	COS announces quadrant xxx	00:00:01.39	00:00:00.00	Normal
10	#6 carries charge to #2	00:00:03.00	00:00:00.00	Normal
11	#6 hands charge to #2	00:00:01.00	00:00:00.00	Normal
12	COS verifies shell	00:00:01.00	00:00:00.00	Normal
15	COS verifies charge	00:00:01.00	00:00:00.00	Normal
16	Rejoin for tasks 6,7, 8	00:00:00.00	00:00:00.00	Normal
17	Driver & #4 position ramming staff	00:00:01.00	00:00:00.00	Normal
18	#4 and Driver position ramming staff	00:00:01.00	00:00:00.00	Normal
20	#1 lowers tray	00:00:01.00	00:00:00.00	Normal
21	#4 announces ready ram	00:00:01.00	00:00:00.00	Normal



First Round Response Function

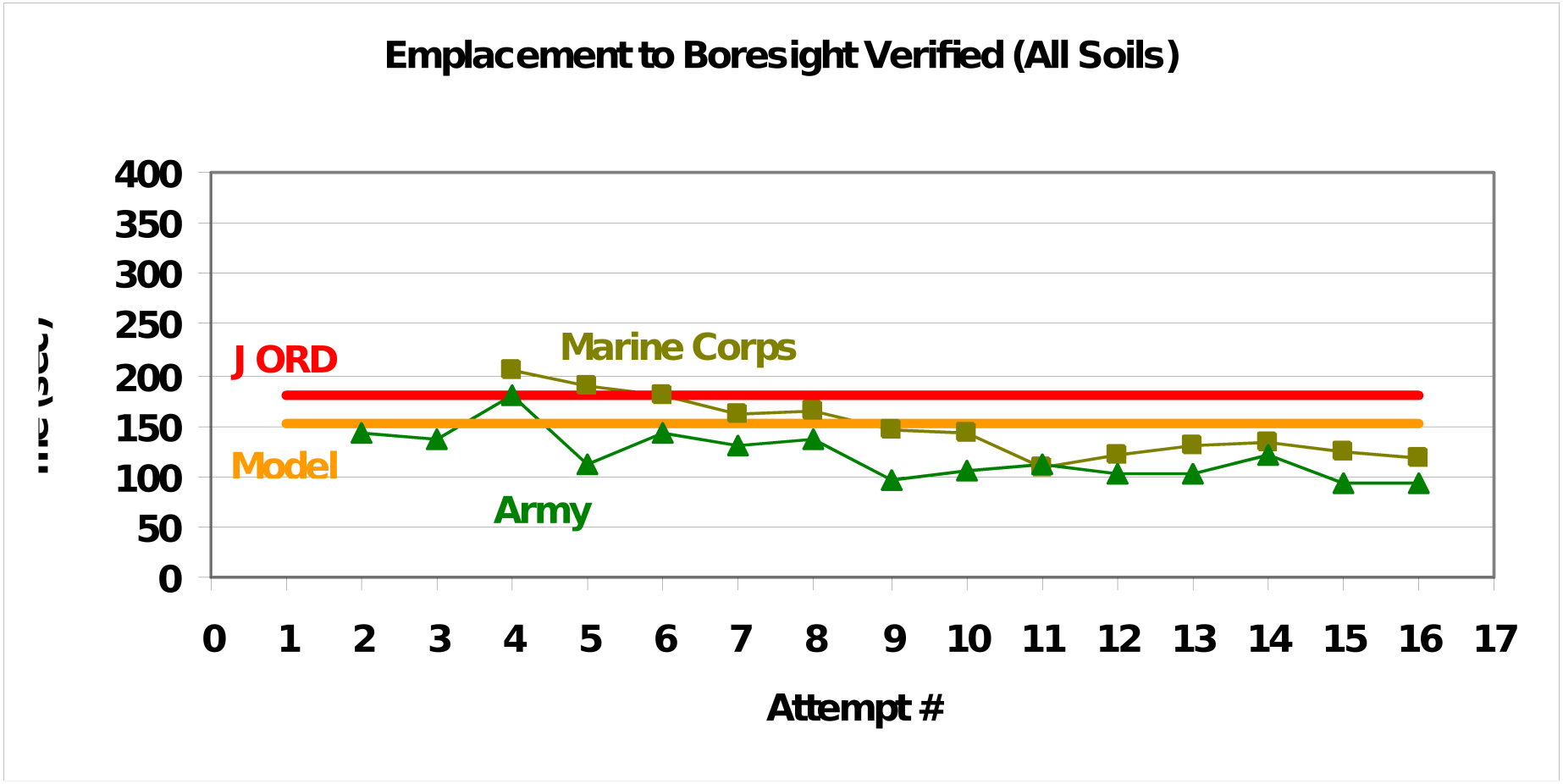
Operational Times

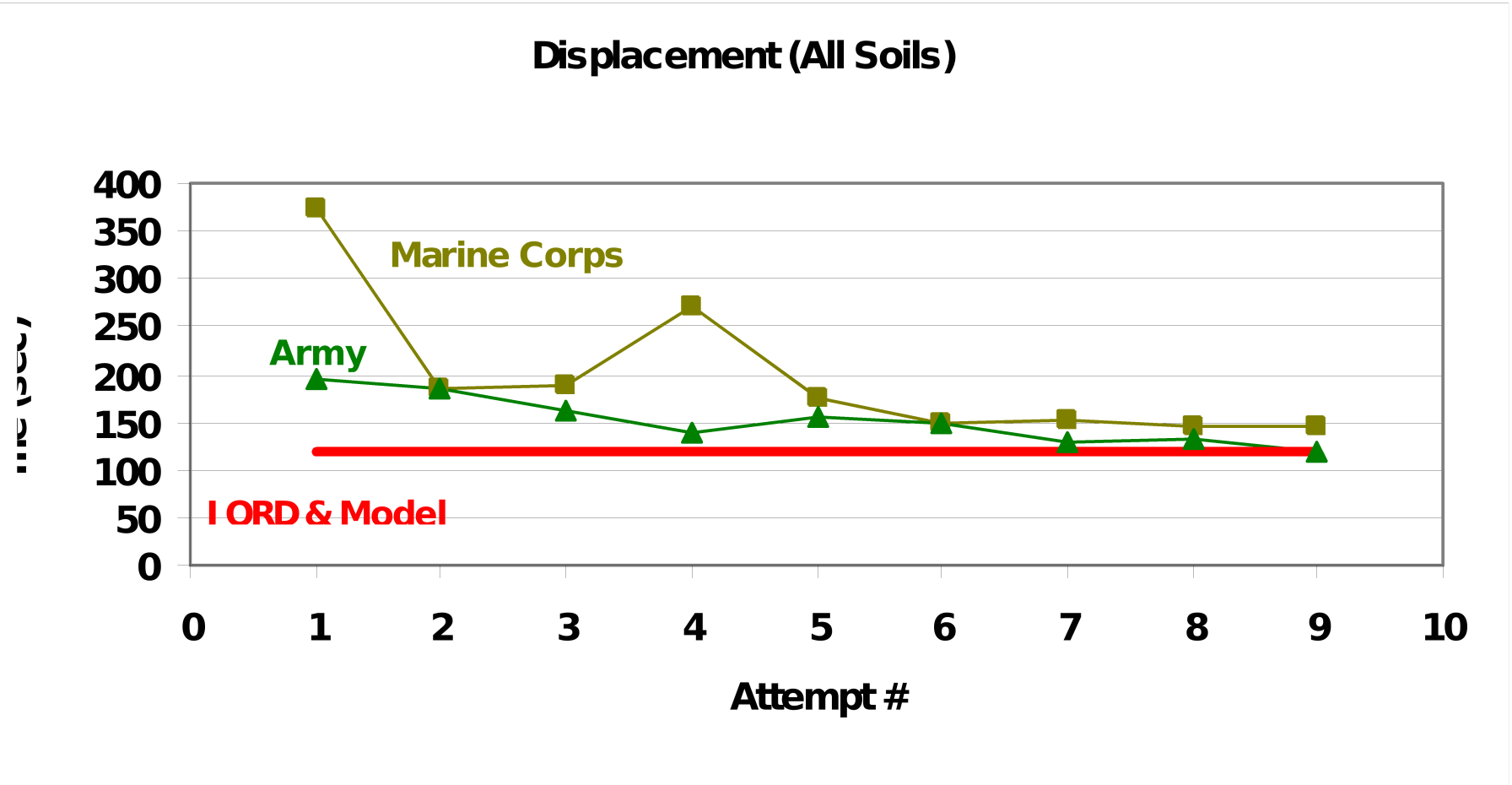
FUNCTION IMPRINT	SHOOT-OFF	JORD
EMPLACEMENT (firm soil) sec	284 sec	180
	184 - 202 sec	
EMPLACEMENT (loose soil)		
180 sec	138 - 152 sec	
DISPLACEMENT	176 sec	120 sec
120 - 134 sec		
RATE-OF-FIRE (for 2 min) rds/min	4.2rd/min	5.0
4.1 - 4.5 rds/min[1]		
BOLD SHIFT sec	423+ sec	180
172 - 204 sec [2]		
1ST RD RESPONSE LOW ANGLE 30 sec	41 sec	
27- 30 sec [3]		

TASK MODEL VALIDATION AT YUMA PROVING GROUND, AZ

- Seven Man Crews to address weapon operations only
- One Crew Each From U.S. Army And USMC
- Trained According To Task Model Assignments For
  - Emplacement
  - Displacement
  - Bold Shift
  - Rate Of Fire
  - 1st Round Response
- Three Soils – Sand, Loam, Hardpack
- Temperature - 70°
- Data Collected
  - Total Time For Each Operation
  - Video

Emplacement


Emplacement to Boresight Verified (All Soils)
400
350
300
250
200
150
100
50
0
J ORD
Marine Corps
Model
Army
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Attempt #


Displacement (All Soils)
400
350
300
250
200
150
100
50
0
Marine Corps
Army
I ORD & Model
0
1
2
3
4
5
6
7
8
9
10
Attempt #

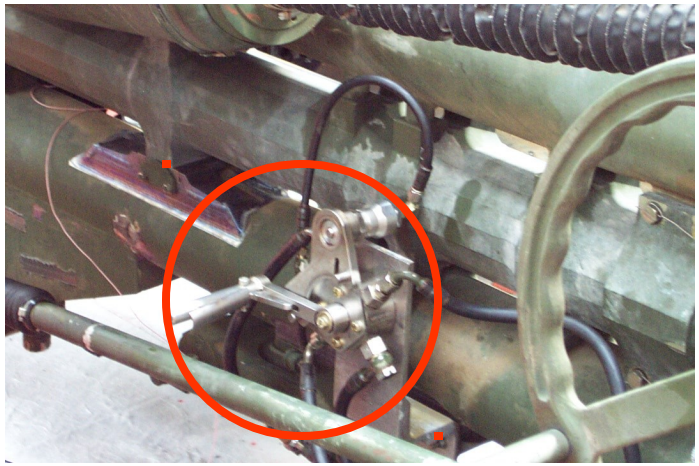
Safety Issue

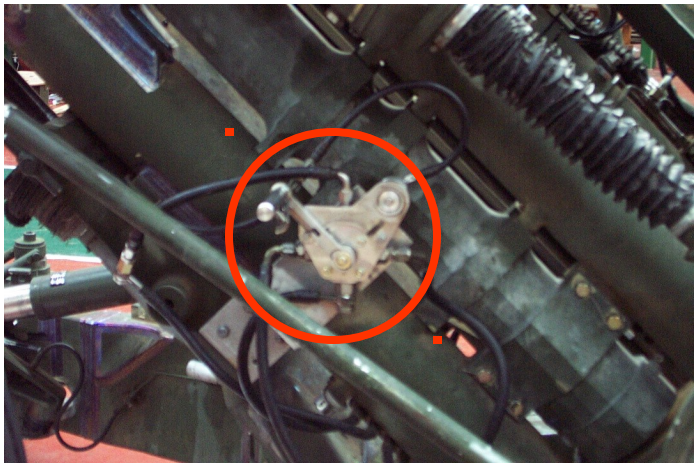
- **Did not record many firing times**
- **The accident that waited to happen**
  - **#2 Cannoneer places charge in cannon by hand**
  - **#1 Cannoneer operates controls to close breech**

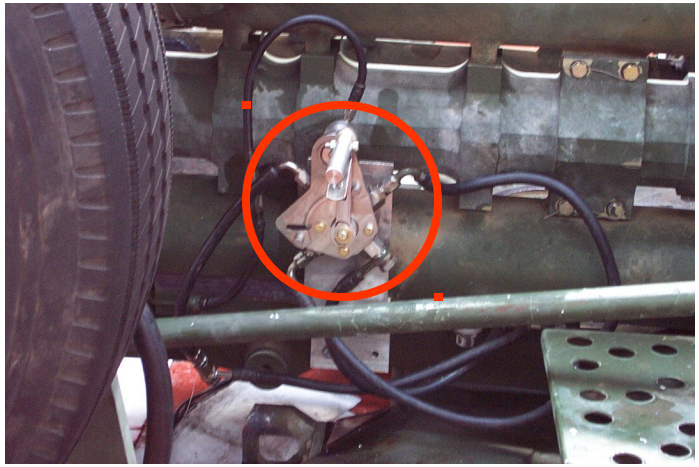
Breech Operating Mechanism

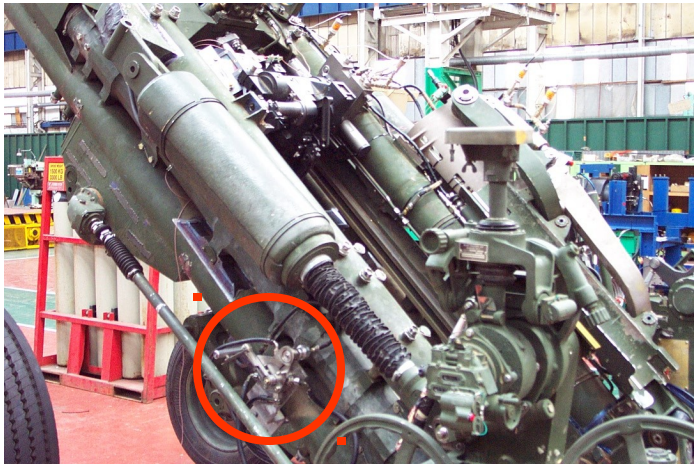
BOM Location

BOM Clearance



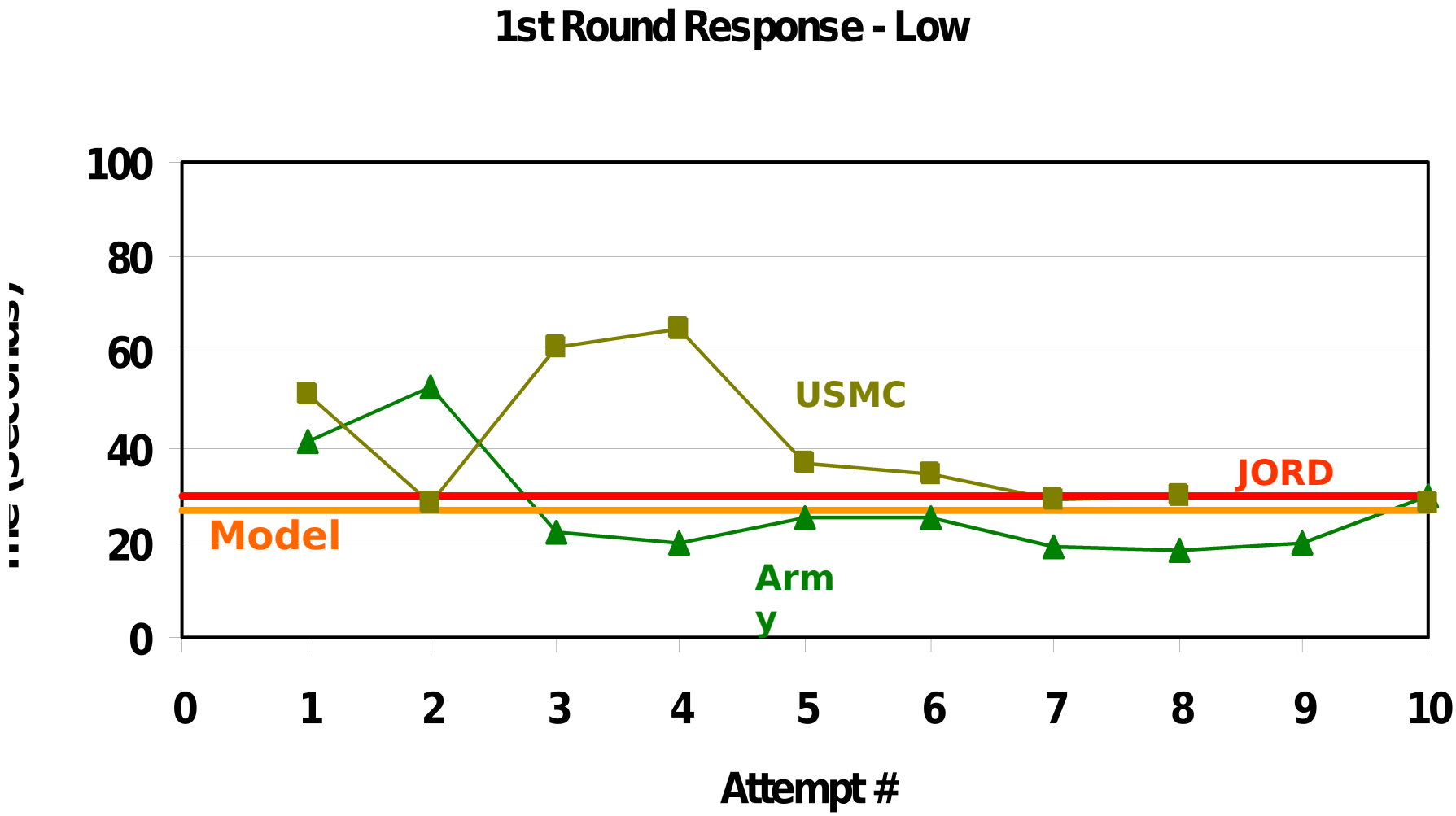


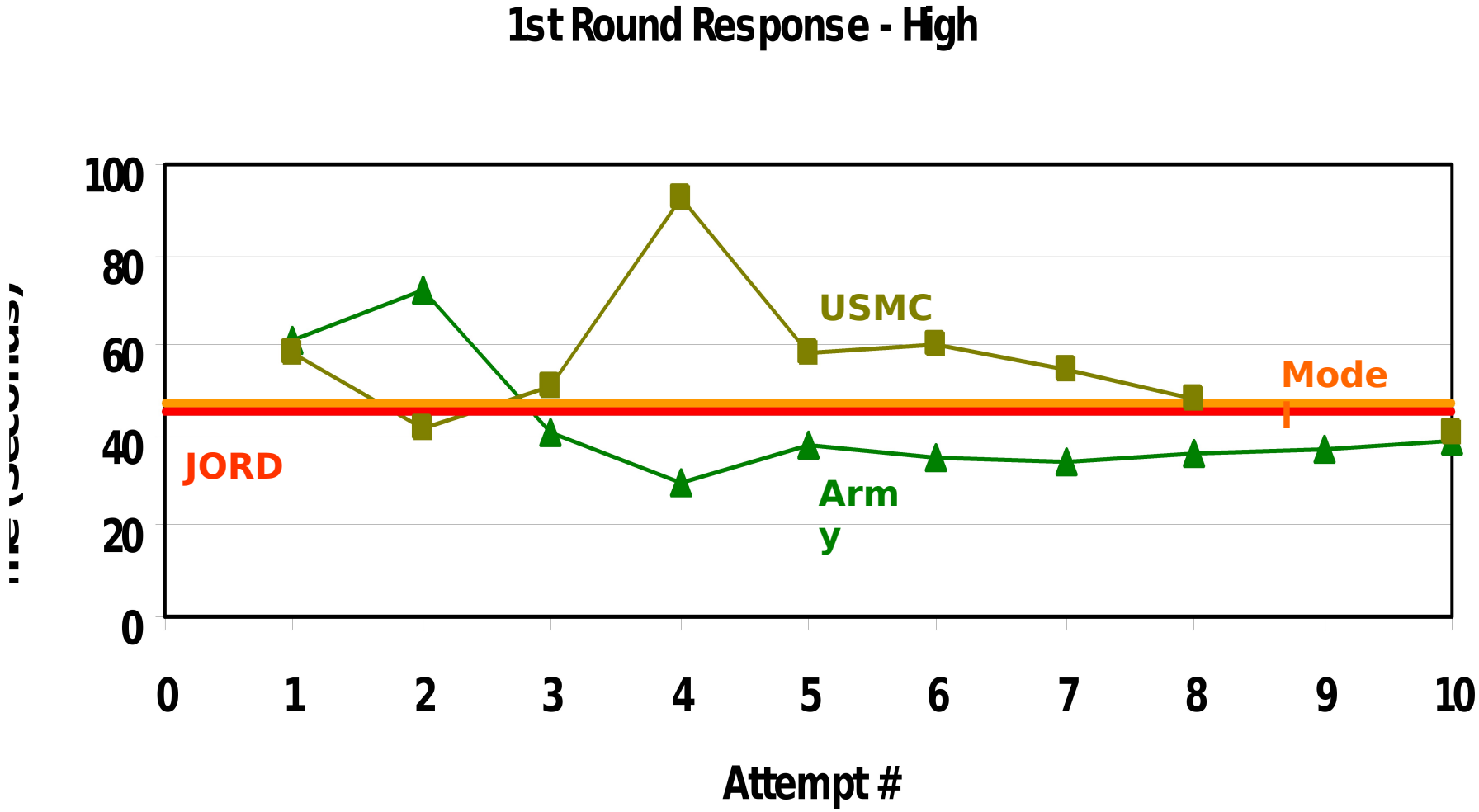




TASK MODEL TESTING AT FT. GREELY, ALASKA

- Ten Men Crews
- One Crew Each From U.S. Army and USMC
- Arctic Gear
- Trained According To Task Model Assignments For
  - Emplacement
  - Displacement
  - Bold Shift
  - Rate Of Fire
  - 1st Round Response
- Three Soils – Soil, Riverbed, Muskeg
- Temperature – (-20° to -45°)
- Data Collected
  - Total Time For Each Operation
  - Video


1st Round Response - Low
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
Attempt #
USMC
JORD
Model
Arm
y


1st Round Response - High
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
USMC
Mode
l
JORD
Arm
y
Attempt #

TASK MODEL VALIDATION RESULTS

- After learning curve, operation times met task model times
- Displacement And Rate-Of-Fire measurements did not meet JORD requirements
- Briefed results to Joint Program Manager (JPM)
- JPM not convinced until the Operational Assessment
- Displacement and Rate-of-Fire requirements were changed

Function	IMPRINT	JORD
Emplacement	138–184 sec	180 sec
Displacement	120–134 sec	120 sec
Rate-of-Fire	4.1–4.5 rds/min 5 rds/min	
Bold Shift	172–204 sec	180 sec
1st Rd Response low	27–30 sec	30 sec
1st Rd Response high	45–49 sec	45 sec

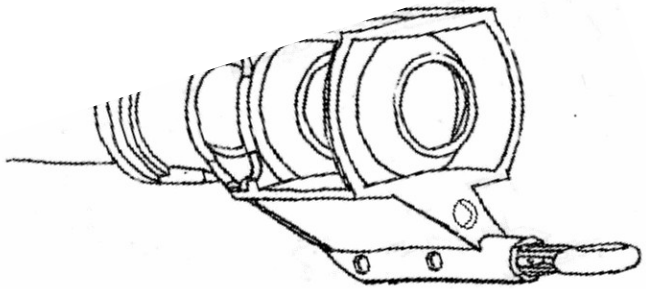
Tongue Weight Challenge

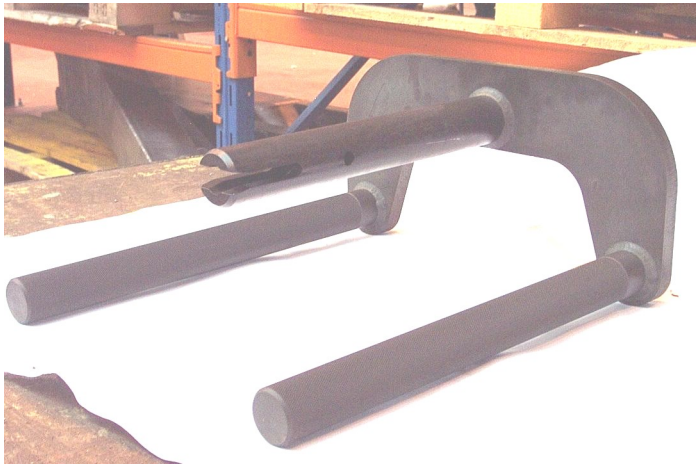
- **Spades strengthened**
- **Center of mass changed**
- **Tongue weight decreased**
- **Unsafe for towing**
- **Add 60 lbs.**
- **Cannot be permanent**

Ballast Bar

- **Provided needed tongue weight**
- **Interference with prime mover**
- **Safety Issue**

Trident Bar

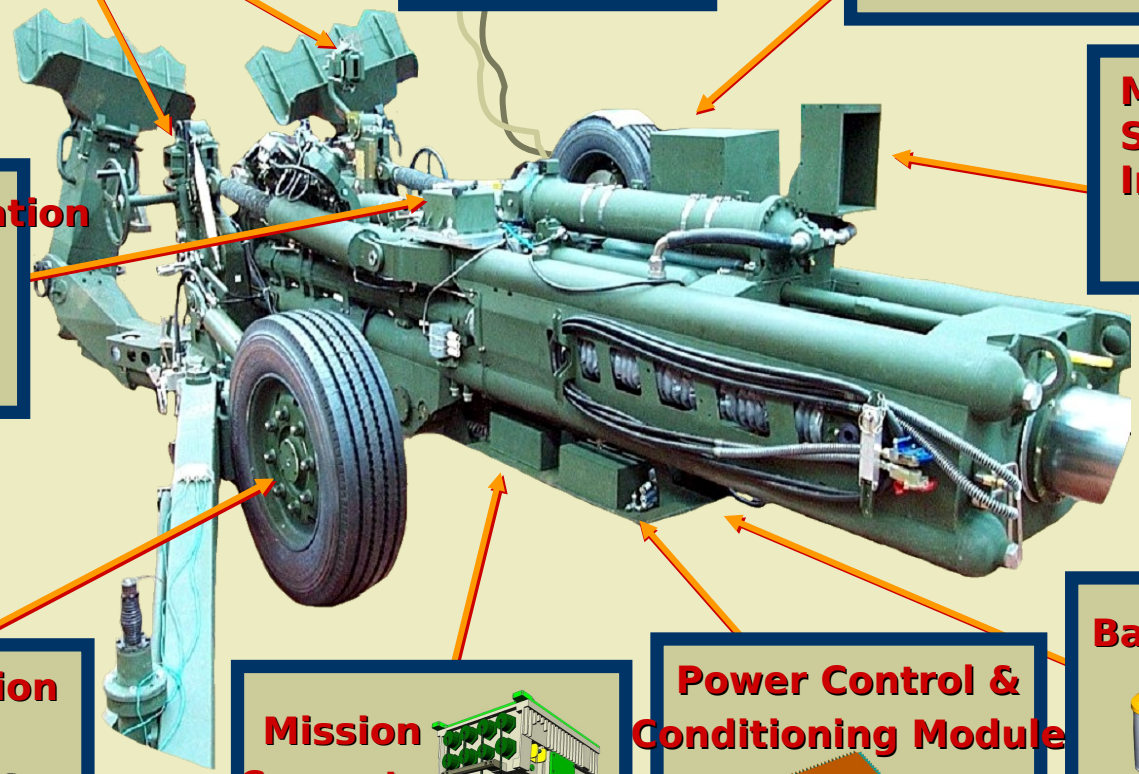




- **Provides needed tongue weight**
- **Dual purpose**
- **Safe**
- **Did not affect emplacement time**

Trident Bar

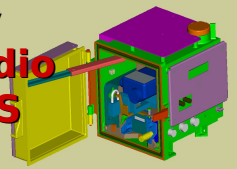
Digital Fire Control System (DFCS)



Gunner & Asst Gunner Displays

Chief of Section Display

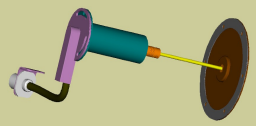
Communication s/ Location Assy
- Radio
- GPS



M94 Muzzle Velocit System (MVS) Interface

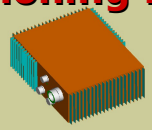
Position/Navigation System

Vehicle Motion Sensor



Mission Compute

Power Control & Conditioning Module



Batteries

Early User Assessment

- **Operational and maintenance tasks**
  - **Cable handling & other tasks**
  - **Remove and replace LRUs**
- **Opportunity for user input**
  - **Additional tasks for DFCS**
  - **Predicted task times**

Early User Assessment

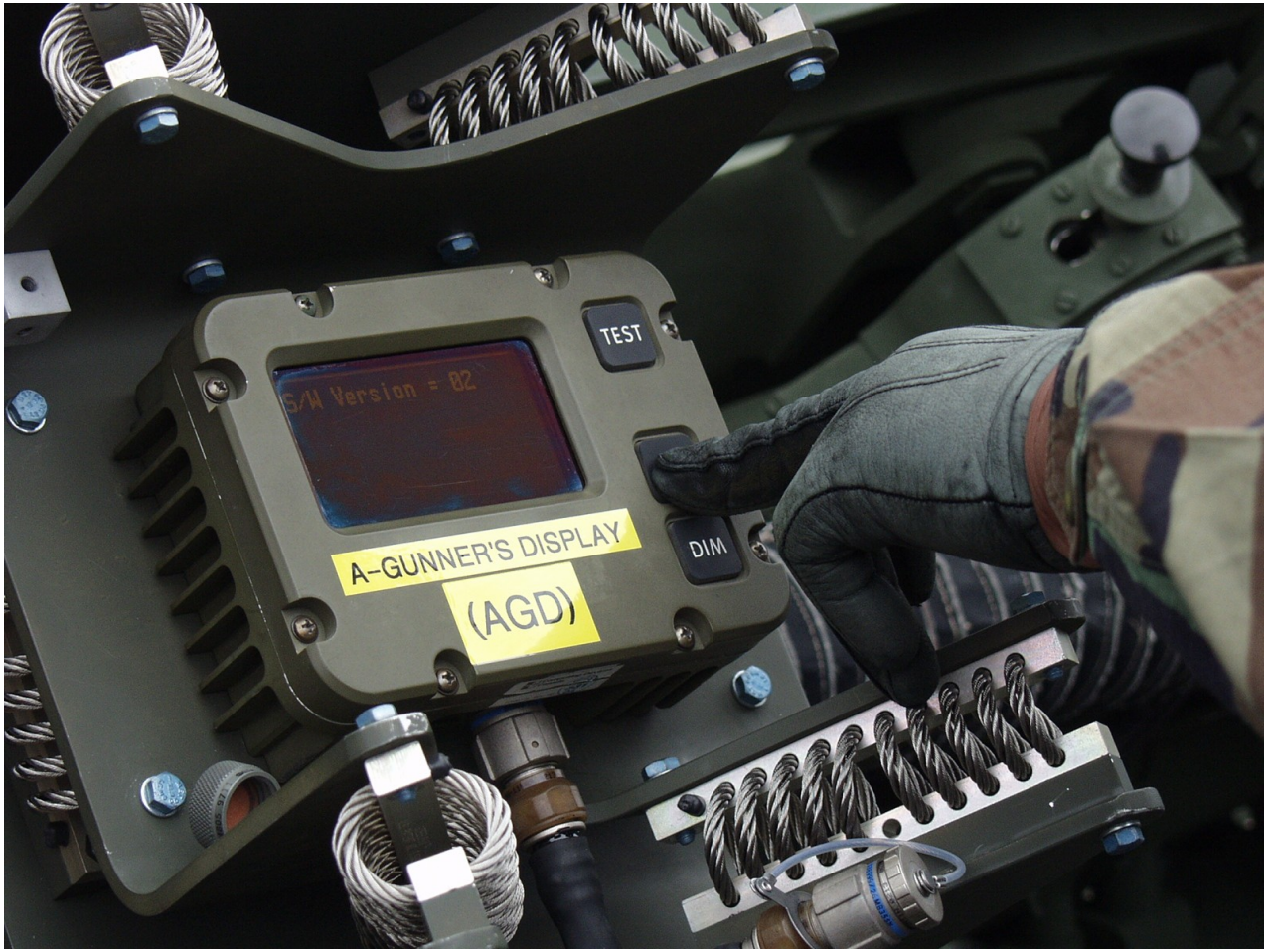
Early User Assessment

Early User Assessment

Early User Assessment

Early User Assessment

Early User Assessment



Early User Assessment

Early User Assessment

Early User Assessment

Early User Assessment

Early User Assessment

Early User Assessment

Outcome

- Crew experienced with weapon
- Questionnaires were administered daily
- Users were interviewed at the end of each day
- Actions and Observations were recorded
- Actions were prioritized and addressed accordingly
- Contractor received valuable input
- Task models were updated or adjusted through recommendations

Summary

- Changes changed things
- Depended on the models
- Depended on HFE experience
- Depended on the users

Future

- Multiservice operational test and evaluation (Sep 04)
- Levels 3 and 4 maintenance logistics demonstration (Nov-Dec 04)

Questions?

Extra